

## CLAIMS

What is claimed is:

- 1     1.     An apparatus for processing an object with a processing fluid, comprising:  
2             a processing chamber formed within a chamber housing; and  
3             a fluid circulation loop integrally formed in the chamber housing.
  
- 1     2.     The apparatus of claim 1 wherein the fluid circulation loop comprises flow generating  
2             means for receiving a fluid and generating a high-velocity fluid stream.
  
- 1     3.     The apparatus of claim 1 further comprising back-flow blocking means adapted and  
2             positioned for allowing the processing fluid to flow unidirectionally from within the  
3             processing chamber to the flow generating means.
  
- 1     4.     The apparatus of claim 3 further comprising filtering means for filtering the processing  
2             fluid.
  
- 1     5.     The apparatus of claim 1 further comprising fluid supply means for supplying a fluid to  
2             the processing chamber.
  
- 1     6.     The apparatus of claim 1 wherein the object is a semiconductor wafer for forming  
2             integrated circuits.
  
- 1     7.     The apparatus of claim 1 further comprising means for recirculating the processing fluid  
2             within the processing chamber for a period of time to remove a contaminant from a  
3             surface of the object.
  
- 1     8.     The apparatus of claim 1 further comprising means for introducing a processing  
2             chemistry into the fluid circulation loop.

- 1     9.     The apparatus of claim 1 further comprising means for maintaining a temperature of at  
2           least one of a fluid within the processing chamber and a fluid within the fluid circulation  
3           loop.
- 1     10.    An apparatus for processing an object with a processing fluid, comprising:  
2           a.     a chamber housing defining a processing chamber, the chamber housing  
3                 comprising:  
4                 i.     fluid inlet means and fluid outlet means in communication with the  
5                     processing chamber;  
6                 ii.    a fluid circulation loop integrally formed in the chamber housing, the fluid  
7                     circulation loop coupling the fluid inlet means and the fluid outlet means;  
8                     and  
9                 iii.   flow generating means for receiving a fluid and generating a high-velocity  
10                 fluid, the flow generating means coupled to the fluid circulation loop; and  
11           b.     fluid supply means for supplying a processing fluid to the processing chamber  
12                 including at least one fluid source.
- 1     11.    The apparatus of claim 10 wherein the fluid inlet means is adapted to direct the high-  
2           velocity fluid stream over the object.
- 1     12.    The apparatus of claim 11 wherein the fluid inlet means is further adapted to allow  
2           substantially all the high-velocity fluid stream to pass over the object within a  
3           predetermined distance from a surface of the object.
- 1     13.    The apparatus of claim 12 further comprising a manifold having a plurality of fluid  
2           outlets for directing the high-velocity fluid stream over the object.
- 1     14.    The apparatus of claim 13 wherein the manifold comprises an injection ring.
- 1     15.    The apparatus of claim 10 wherein the flow generating means is configured to receive a  
2           fluid from at least one of the fluid supply means and the fluid outlet means.

- 1     16.     The apparatus of claim 10 further comprising back-flow blocking means adapted and  
2             positioned for allowing the processing fluid to flow unidirectionally from within the  
3             processing chamber to the flow generating means.
- 1     17.     The apparatus of claim 16 wherein the back-flow blocking means comprises at least one  
2             check valve.
- 1     18.     The apparatus of claim 10 wherein the object is a semiconductor wafer for forming  
2             integrated circuits.
- 1     19.     The apparatus of claim 10 further comprising means for recirculating the processing fluid  
2             within the processing chamber for a period of time to remove a contaminant from a  
3             surface of the object.
- 1     20.     The apparatus of claim 10 wherein the fluid comprises at least one of gaseous, liquid,  
2             supercritical and near-supercritical carbon dioxide.
- 1     21.     The apparatus of claim 20 wherein at least one of solvents, co-solvents, chemistries, and  
2             surfactants are contained in the carbon dioxide.
- 1     22.     The apparatus of claim 10 further comprising filtering means for filtering the processing  
2             fluid.
- 1     23.     The apparatus of claim 22 wherein the filtering means is configured to reduce a  
2             contaminant level of the processing fluid.
- 1     24.     The apparatus of claim 23 wherein the filtering means is further configured to have at  
2             least one of a course filter and a fine filter.
- 1     25.     The apparatus of claim 10 further comprising fluid supply means for supplying a fluid  
2             from the fluid source to the processing chamber.

- 1     26.     A semiconductor wafer processing apparatus, comprising:  
2             a processing chamber formed within a chamber housing, the chamber housing  
3     having a fluid inlet and a fluid outlet in communication with the processing chamber;  
4             a first fluid communication line integrally formed in the chamber housing and  
5     coupling the fluid outlet and the fluid inlet, the first fluid communication line including a  
6     pump for generating a high-velocity fluid stream; and  
7             filtering means for filtering the processing fluid.
- 1     27.     The semiconductor wafer processing apparatus of claim 26 wherein the fluid inlet is  
2     adapted to direct the processing fluid over the object.
- 1     28.     The semiconductor wafer processing apparatus of claim 26 wherein the fluid  
2     communication line includes a back-flow blocking means adapted for allowing a  
3     processing fluid to flow unidirectionally from the fluid outlet to the fluid inlet.
- 1     29.     The semiconductor wafer processing apparatus of claim 28 wherein the back-flow  
2     blocking means comprises at least one check valve.
- 1     30.     The semiconductor wafer processing apparatus of claim 26 wherein the filtering means is  
2     coupled to the fluid communication line.
- 1     31.     The semiconductor wafer processing apparatus of claim 26 wherein the filtering means is  
2     configured to reduce a contaminant level of the processing fluid.
- 1     32.     The semiconductor wafer processing apparatus of claim 31 wherein the filtering means is  
2     further configured to have at least one of a course filter and a fine filter.
- 1     33.     The semiconductor wafer processing apparatus of claim 26 further comprising a second  
2     fluid communication line integrally formed in the chamber housing and coupling the fluid  
3     outlet and the fluid inlet, the second fluid communication line including a pump for  
4     generating a high-velocity fluid stream.

- 1     34.     The semiconductor wafer processing apparatus of claim 26 further comprising fluid  
2             supply means for supplying a processing fluid to the processing chamber including at  
3             least one fluid source.
- 1     35.     A method of processing an object with a processing fluid, comprising the steps of:  
2             a.         circulating a fluid stream within a fluid circulation loop integrally formed in a  
3                         chamber housing; and  
4             b.         generating a high-velocity fluid stream within a processing chamber.
- 1     36.     A method of removing at least a portion of a residue from a surface of a semiconductor  
2             wafer with a processing fluid, comprising the steps of:  
3             a.         increasing a frictional force of the processing fluid over the surface of the  
4                         semiconductor wafer by generating a high-velocity processing fluid stream; and  
5             b.         circulating the processing fluid within a fluid circulation loop integrally formed in  
6                         a chamber housing.
- 1     37.     A method of making a supercritical processing apparatus, comprising the steps of:  
2             a.         forming a processing chamber within a chamber housing; and  
3             b.         integrally forming at least one fluid circulation loop in the chamber housing for  
4                         use in generating a high-velocity fluid stream within the processing chamber.
- 1     38.     The method of claim 37 further comprising the step of providing a filtering means for  
2             filtering a fluid to reduce a contaminant level of the fluid.